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TRITIUM EXPERIENCE AT RTNS-II

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Tritium Experience at RTNS-II

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The Rotating Target Neutron Source - II (RTNS-II) is the first facility within the Magnetic Fusion Energy program which routinely handles tritium in order to function. The two accelerator-based neutron sources in this facility are dedicated to fusion materials research. Over 10^{13} 14-MeV neutrons per second are produced by accelerating deuterons to 400 keV and bombarding a TiT_2 target. Tritium is released from these targets into the accelerator vacuum system. Vacuum pumping is continuous-throughput via turbomolecular/mechanical pumps exhausting to a central tritium scrubber[1]. The scrubbed exhaust is then released via the facility stack.

All components of the ion source, accelerator, beam transport system, target system, vacuum equipment, exhaust lines and target cooling water system become tritium contaminated. Repair and maintenance is accomplshed using techniques and procedures which meet the "as low as reasonably achievable" criterion. Components in the vacuum system near the target typically have 10^6-10^7 dpm/cm^2 of surface contamination which is removable by swiping. The beam line three meters away from the target is about two orders of magnitude lower in contamination levels. At the ion source swipable tritium contamination is quite low, typically 30-300 dpm/cm^2.

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Tritium hold-up in turbo pump oil is minor but the inventory in mechanical pump oil is appreciable. On several occasions water leakage to the vacuum system when subsequently pumped through the mechanical pumps has condensed, leaving water with concentrations of several Ci/ℓ of tritium in the exhaust lines. This water is also probably the major cause of hold-up in pump oil.

Tritium release from the facility in normal operation with vacuum system exhaust flowing through the scrubber is extremely low, < 1mCi/day. The original facility design envisioned direct stacking of pump exhaust during roughing since no tritium gas load would be present. This allowed designing the scrubber for the modest flow rates required to handle ion source gas load and vacuum system leakage. Experience has shown that pump-downs are the major source of tritium release, probably because of tritiated water released from mechanical pump oil during high throughput. Release rates as high as 50 mCi/sec have been observed for a few seconds. Liquid effluent is controlled by a closed gravity-feet drain system from all rooms where liquid leakage could occur. This system drains to a retention tank which is pumped for disposal.

Routine target changes have been the cause of most tritium uptake experienced by personnel. Urine concentrations of 0.5 - 1.5 μCi/ℓ are usually observed after handling a fresh target. Spillage of contaminated water and oil have been the cause of most "housekeeping" problems and tracking of tritium beyond the target room and hot work areas. The largest single exposure resulted from spilling of condensate from the vacuum exhaust line. A tritium concentration of 10 μCi/ℓ was recorded in one worker who splashed water with a concentration of 4 Ci/ℓ on exposed skin. The integrated dose from this exposure is approximately 40 mR.

At RTNS-II airborne tritium must be monitored in the presence of residual γ activity. Because of this, portable instrumentation must usually be located at a considerable distance from the workplace and fed an air-sample by hose. The facility has a network of sample lines which bring air samples from all work areas where tritium is expected to a central monitoring location. The length of piping runs results in a time response of 2-7 minutes for these monitors. Readout capability is presently only at the instrument location with two separate level alarms relayed to the control room. The stack concentration and flow rate is recorded. The minimum concentration which can be reliably measured is 5 $\mu Ci/m^3$. Integral release is measured by a separate system utilizing room-temperature catalyst and silica-gel drier. The silica gel is analyzed at a central LLL facility along with other similar monitors. Monthly release from the facility has been 1-3 Ci.

Contaminated parts are moved to a hood for repair or service. Face velocity of air across the opening is maintained at 1 m/s. At RTNS-II no measurable tritium uptake has occurred to any worker from handling contaminated parts in the hood while following appropriate procedures including protective clothing. The handling of used tritium targets poses the possible risk of particulate ingestion. Respirators are used in this situation as a precaution.

Targets in storage release tritium at $\sim$ 1 nCi/s. RTNS-II targets are stored in an evacuated canister which is purged prior to opening. Shipping of loaded 23cm targets utilizes CFR49 specification 2R containers and 20WC wooden overpack. Shipping of 50 cm targets is accomplished in a specially designed and certified shipping package.

A commercial overpack is used in conjunction with a standard drum and individual evacuated target containers. The system demonstrated containment after unusually severe testing.

1. B. J. Schumacher "RTNS-II Tritium Scrubber Design and Performance" This conference.